notation) was equal to the total quantity incident upon the object glass, viz. $\iint dx\,dy$=area of object glass, where the intensity, *i.e.* the quantity of light per unit area, incident on the object glass is unity.

The incident light was regarded as coming from a *single distant point*, so that the wave front on the object glass was plane, with uniform distribution over it.

The integral was taken over the diffraction pattern nominally between the limits $-\infty$ and $+\infty$ for both ξ and η, but practically the quantity of light contributed by an element of area in the focal plane falls off very rapidly as the distance of the element from the centre of the diffraction pattern increases.

The meaning of the infinite limits is entirely different in the case which Professor Wadsworth deals with. *Each point* in the uniformly illuminated sky considered by him contributes to the illumination of the photographic plate a quantity of light which is proportional to the area of the object glass; but *the scale of the photograph of the sky* depends on the focal length of the object glass.

The criticism and attempted explanation which Professor Wadsworth gives of practical results obtained with large and small reflectors and refractors falls to the ground. Professor Wadsworth's conclusions are incorrect.

In the *Astrophysical Journal*, vol. vi. 1897 August, p. 132, it is clear that there is discontinuity in Wadsworth's solutions. On p. 132 he arrives at the correct result that for large finite illuminated surfaces the intensity on the photographic plate is proportional to $\frac{A^2}{f^2}$. But on the following page he reaches the incorrect result that for the large sky the intensity is proportional to A^2.

On the Apparent Diurnal Motion of Stars in relation to the Adjustment of the Polar Axis of a Telescope. By C. Davidson, Royal Observatory, Greenwich.

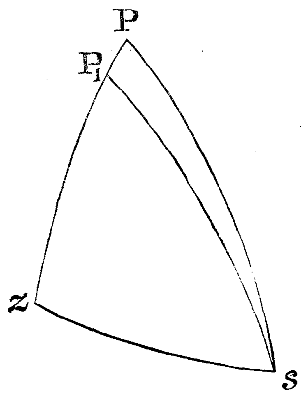
(*Communicated by W. H. M. Christie, Astronomer Royal.*)

In *Monthly Notices*, vol. 57, No. 2, Professor Rambaut has discussed the variable effect which refraction has on the apparent motion of stars, and proposes a method by which an equatorial telescope may be kept accurately pointed on a star by introducing corresponding variations into the rate of the driving clock.

In this paper, however, he does not take into account any want of adjustment of the polar axis of the telescope. If this does not point to the Pole, an additional variation in the rate of

the driving clock will be required to correct for this. At Greenwich the polar axes of the photographic equatorials have been adjusted so that when the instrument is pointed to, or near, the Pole, and the clock is rated to sidereal time, no elongation of the images occurs. This implies that the polar axis of the telescope does not point to the true, but to the apparent Pole (as affected by refraction). That this is the case can be easily seen by making the supposition that there is a star at the Pole. This will be seen at the apparent Pole, and to obtain a round image of it the polar axis of the equatorial must be pointed to it.

When an equatorial is adjusted in this manner the alteration required in the rate of the clock in order to keep the telescope accurately pointed is very different from that required when refraction only is considered, and does not become infinite at the Pole, which would not be the case if the axis were adjusted to the true Pole. But even if a telescope is not adjusted in this way, as the polar axis is rarely pointed accurately to the true Pole, it may be of interest to consider the effect of this error.



Leaving out refraction and considering only the elevation of the Pole, if P is the true, P_1 the instrumental Pole, z the zenith, and s a star,

Then

$P\,P_1$ is the error of elevation $= e$.

$z\,P\,s$ is the hour angle of the star $= h$.

$$P\,s = \frac{\pi}{2} - \delta.$$

$z\,P_1\,s$ is the hour angle as shown by the telescope.

Therefore

$$\Delta h = e \sin h \,.\, \tan \delta.$$

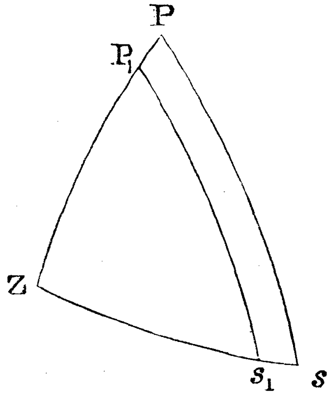
And

$$\frac{d\,\Delta h}{d\,h} = e \cos h \,.\, \tan \delta,$$

which, e being known, may be easily applied as a correction to Professor Rambaut's table.

But I wish to consider at greater length the result when, as

at Greenwich, P_1 is also the apparent Pole, combining with it the variation due to refraction.



As before z, P, and s are the zenith, pole, and a star.
P_1 the apparent and instrumental Pole.
s_1 the star as affected by refraction.
Then

$$z\,P = \text{colatitude} = c,$$

$$z\,s = \text{zenith distance} = z,$$

$$P\,s = \frac{\pi}{2} - \delta,$$

and

$$P\,s\,z = \text{angle Q}.$$

Then

$$\Delta h = -\Delta c \sin h \,.\, \tan \delta + \Delta z \frac{\sin h \,.\, \sin c}{\sin z \,.\, \cos \delta}.$$

Putting $\Delta c = -k \tan c$,
and $\Delta z = -k \tan z$, where k is the constant of refraction; this becomes

$$\Delta h = -k \sin h \,.\, \tan c \tan z \,.\, \cos Q,$$

and the change of rate is given by

$$\frac{d\Delta h}{dh} = -k\,(\tan c \,.\, \cos h \tan z \,.\, \cos Q + \sin^2 c \,.\, \sin^2 h \sec^2 z).$$

The computation of tables from this formula is simplified by the introduction of an auxiliary angle θ defined by

$$\tan \theta = \tan c \,.\, \cos h,$$

for

$$\tan z \,.\, \cos Q = \frac{1 - \tan c \tan \delta \,.\, \cos h}{\tan \delta + \tan c \,.\, \cos h}$$

$$= \cot (\delta + \theta),$$

and

$$\cos z = \frac{\cos c \sin(\delta + \theta)}{\cos \theta},$$

and the formula then becomes

$$\frac{d\Delta h}{dh} = -k \left\{ \tan\theta \cot(\delta+\theta) - \frac{\tan^2 c \, . \, \sin^2 h \cos^2\theta}{\sin^2(\delta+\theta)} \right\}.$$

When special cases are considered some interesting modifications occur in the formula.

On the meridian it simplifies to

$$\frac{d\Delta h}{dh} = -k \tan c \tan z,$$

and at 6^{hrs} from the meridian

$$\frac{d\Delta h}{ah} = -k \tan^2 c \, . \, \operatorname{cosec}^2 \delta.$$

Near the Pole the rate is

$$+k \tan^2 c \cos 2h.$$

It should be noted that this is finite, and that the elongation of the image of any star will be infinitesimal.

It will be observed that the effect of this adjustment disappears at the equator, and also at six hours from the meridian, leaving the effect due to refraction only, and is greatest near the Pole on the meridian, where the effect of refraction is eliminated.

Table I. exhibits the results obtained, in daily rates, + signifying a gaining and — a losing rate.

TABLE I.

Hour Angle.

Decl. °	0^h s	1^h s	2^h s	3^h s	4^h s	5^h s	6^h s	7^h s	8^h s	9^h s	10^h s	11 s	12^h s
−20	−57·3	−65·6	−104·6										
15	−44·1	−49·0	−69·7										
10	−35·3	−38·5	−51·3	−91·2									
−5	−29·0	−31·2	−39·9	−63·9									
0	−24·1	−25·8	−32·1	−48·1	−96·3								
+5	−20·2	−21·6	−26·5	−38·0	−68·1								
10	−16·9	−18·1	−22·1	−30·9	−51·3	−112·7							
15	−14·2	−15·2	−18·6	−25·7	−40·5	−77·9							
20	−11·7	−12·7	−15·7	−21·7	−33·1	−57·7	−130·5						
25	−9·6	−10·4	−13·2	−18·5	−27·7	−45·0	−85·5						
30	−7·6	−8·4	−11·1	−15·9	−23·6	−36·5	−61·1	−123·0					
35	−5·7	−6·5	−9·1	−13·6	−20·4	−30·5	−46·4	−75·5					
40	−3·9	−4·8	−7·4	−11·7	−17·9	−26·2	−37·0	−51·4	−71·5				
45	−2·2	−3·1	−5·7	−10·1	−15·8	−22·9	−30·5	−37·7	−41·0	−31·8			
50	−0·5	−1·4	−4·2	−8·5	−14·1	−20·3	−26·0	−29·2	−26·2	−10·7			
55	+1·2	+0·2	−2·7	−7·2	−12·7	−18·4	−22·8	−23·8	−18·2	−2·7	+23·3	+51·8	+64·8
60	+2·9	+1·8	−1·3	−6·0	−11·5	−16·8	−20·4	−20·1	−13·6	+0·6	+20·9	+40·4	+48·7
65	+4·6	+3·5	+0·1	−4·8	−10·5	−15·6	−19·5	−17·6	−10·8	+1·8	+18·2	+32·6	+38·5
70	+6·4	+5·2	+1·5	−3·7	−9·6	−14·7	−17·3	−15·8	−9·2	+2·1	+15·6	+26·9	+31·3
75	+8·3	+6·9	+3·0	−2·7	−8·9	−14·0	−16·4	−14·7	−8·2	+1·9	+13·4	+22·4	+25·9
80	+10·4	+8·8	+4·5	−1·8	−8·3	−13·5	−15·7	−13·9	−7·7	+1·4	+11·3	+18·9	+21·7
85	+12·7	+10·9	+6·0	−0·8	−7·9	−13·3	−15·4	−13·4	−7·6	+0·8	+9·4	+15·8	+18·2
+90	+15·3	+13·2	+7·6	−0·0	−7·6	−13·2	−15·3	−13·2	−7·6	0·0	+7·6	+13·2	+15·3

The following table is a comparison of the necessary changes in the clock rate near the meridian when the polar axis is adjusted to the true Pole with those when it is adjusted to the apparent Pole :—

TABLE II.

Decl.	Rate on the meridian polar axis adjusted to the True Pole.	Rate on the meridian polar axis adjusted to the Apparent Pole.	Decl.	Rate on the meridian polar axis adjusted to the True Pole.	Rate on the meridian polar axis adjusted to the Apparent Pole.
°	s	s	°	s	s
−20	−52·0	−57·3	+55	−25·6	+1·2
15	40·5	44·1	60	29·4	2·9
10	32·7	35·3	65	35·6	4·6
−5	27·8	29·0	70	44·5	6·4
0	24·3	24·1	75	63·3	8·3
+5	22·0	20·2	80	−94·0	10·4
10	20·3	16·9	85	...	12·7
15	19·2	14·2	90	...	15·3
20	18·6	11·7	85 S.P.	...	18·2
25	18·3	9·6	80 S.P.	+121·9	21·7
30	18·4	7·6	75 S.P.	93·4	25·9
35	18·9	5·7	70 S.P.	76·9	31·3
40	19·6	3·9	65 S.P.	70·5	38·5
45	21·1	2·2	60 S.P.	72·0	48·7
+50	−22·8	−0·5	55 S.P.	+79·7	+64·8

As regards the change in the apparent declination of a star due to this adjustment

$$\Delta\delta = -\Delta c \cos h,$$

and

$$\frac{d\Delta\delta}{dh} = +\Delta c \sin h,$$

h being the westerly hour angle.

This change will be seen to vanish on the meridian, but, on either side of it, will go in an opposite direction to that due to refraction.

The Great Equatorial Current of Jupiter.
By A. Stanley Williams.

I. *On the Rate of Rotation in* 1897.

Observations were made here last spring with the object of determining the present rate of rotation of the great equatorial current of *Jupiter*. Valuable observations were also received from the undermentioned observers, and have been of great assistance in this research—namely, Messrs. E. M. Antoniadi, Juvisy; L. Brenner, Lussinpiccolo; H. F. Griffiths, Streatham; H. MacEwen, Glasgow; W. H. Maw, South Kensington; T. E. R. Phillips, Yeovil. So that, although the weather proved exceptionally unfavourable, eight spots situated on the north side of the south equatorial belt were observed sufficiently well to enable good determinations of the rotation period to be derived. The observations of these spots are given further on.

In all work of this kind it is of the utmost importance that there should be no possibility of doubt concerning the identity of the markings observed. It is very desirable, therefore, that observers, when stating the results of their investigations, should publish also the observations upon which these results are based; and this is even more important when such results differ materially from those of earlier investigators. In the present instance I have been careful not to include any doubtful cases, and the observations are so numerous, so distributed, and so accordant, that it seems impossible that there can be any doubt as to identity. Most of the columns in the following tables explain themselves. The third column gives the weight attributed to the observation at the time on a scale ranging from 1 (bad) to 5 (good).* The rotation periods have been computed from certain selected observations, and these weights are useful in selecting the best observations, but they have not been made use of in any other way in the calculations. The residuals in the fifth column will show how far the observations are satisfied by the adopted period of rotation in the case of each spot. The longitudes in column 4 are according to "System I" of the late Mr. Marth's Ephemeris. The last column contains the initials of the observer.†

* For the meaning of "est." = estimated transit in connection with an observation by Mr. MacEwen, see *Journal B.A.A.* vol. vii. p. 271; and in connection with an observation by the writer, see *Monthly Notices*, vol. liv. p. 298.

† Most of the transits of equatorial spots by Mr. Gledhill, published in the Supplementary Number of the *Monthly Notices*, refer to spots on the N. equatorial belt. An observation of the dark spot *b* on May 9 has, however, been added in its proper place. A small *bright* spot on the N. edge of his belt 3 is stated to have been on the central meridian, at $8^h\,27^m$, on April 28. This would give a position close to the *dark* spot *c*, so that belt 3 is probably a misprint for 5.